
Trough Technology Heat Collector Element (HCE) Solar Selective Absorbers

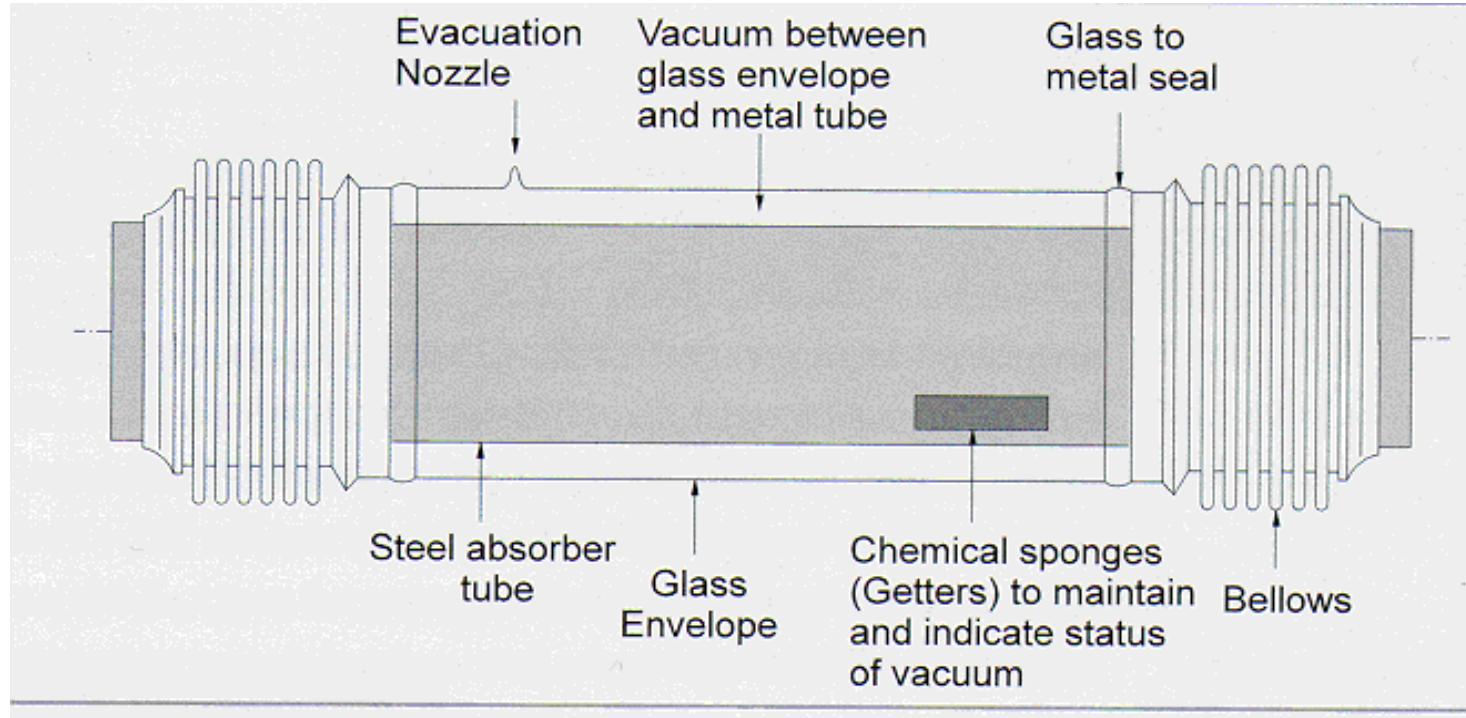
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Sandia National Laboratories

June 18, 2000

Trough Workshop ASES 2000

Typical Evacuated Heat Collector Element (HCE)



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HCE (Receiver) Reliability

Background

HCE (Receiver) failure / degradation is the single largest cost factor [both performance and O&M] for current & future plants

- **30-40% failure at SEGS VI-IX (9 to 11 years of operation)**
- **loss of vacuum (glass-to-metal seal or other), solar selective coating degradation in air, broken glass**
- **Replacement cost is ~\$1000 / HCE (evacuated)**
- **Annual O&M cost is 0.5 ¢/kWh (Cost/Perf)**



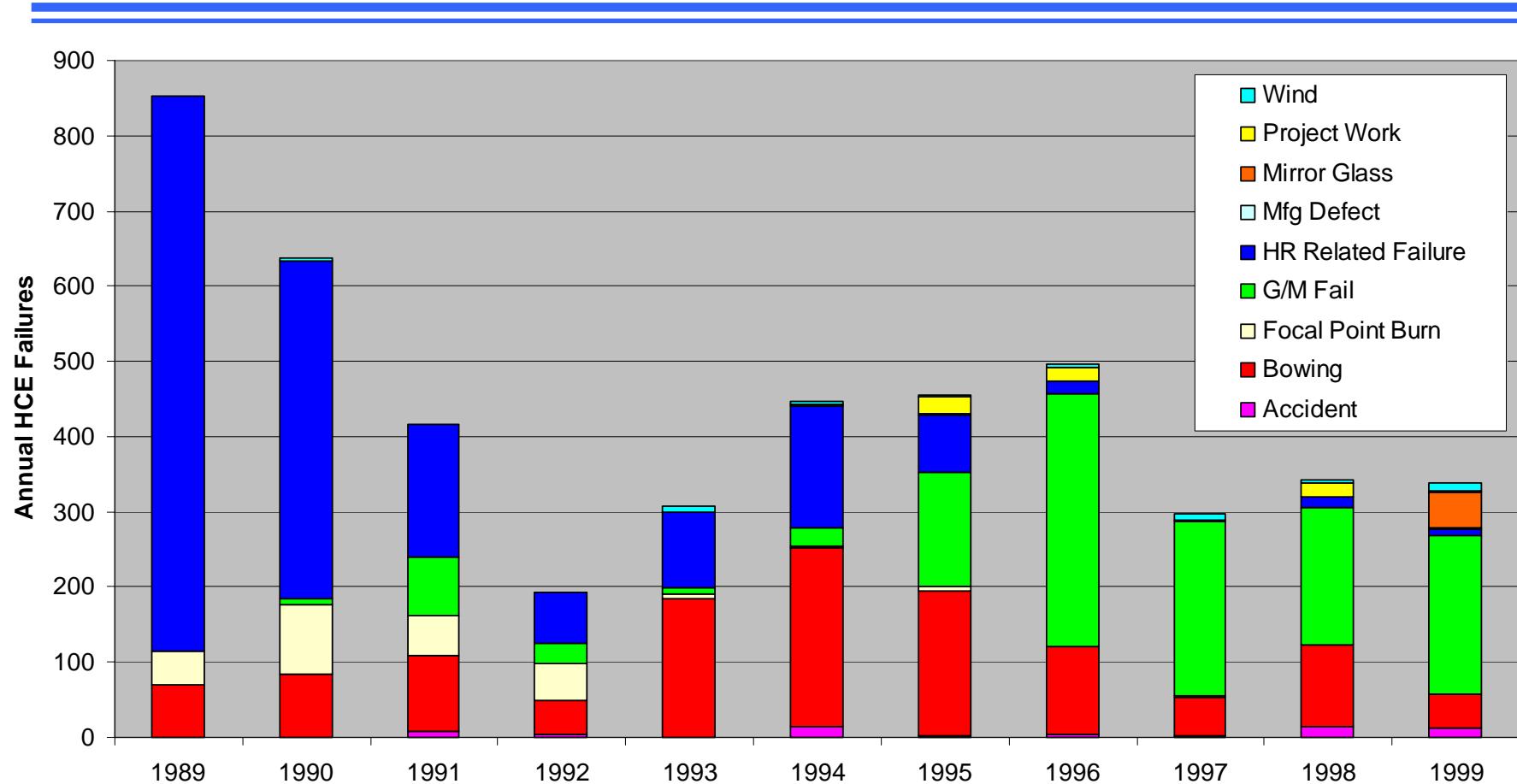
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HCE (Receiver) Reliability - MWE Study

SEGS VI LS-2 Failures by Cause





SEGS 8 & 9 Harper Lake HCE “Fluorescent” Tubes

-Vacuum Challenged



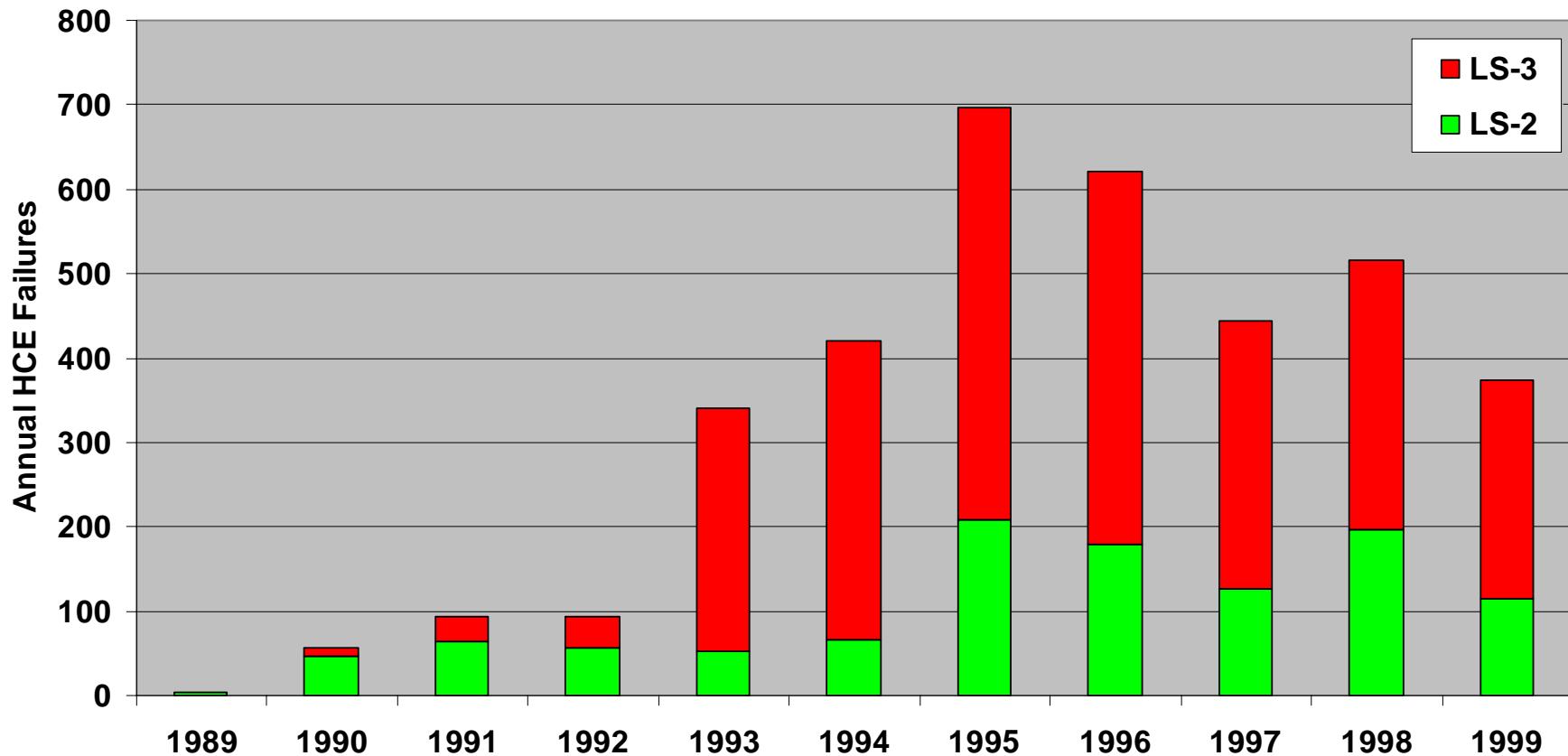
Glass-to-metal seal failures

Causes:

- Flux Induced Thermal Stress
(increased in winter)
- Hydrogen Removal Tube
- Vibration

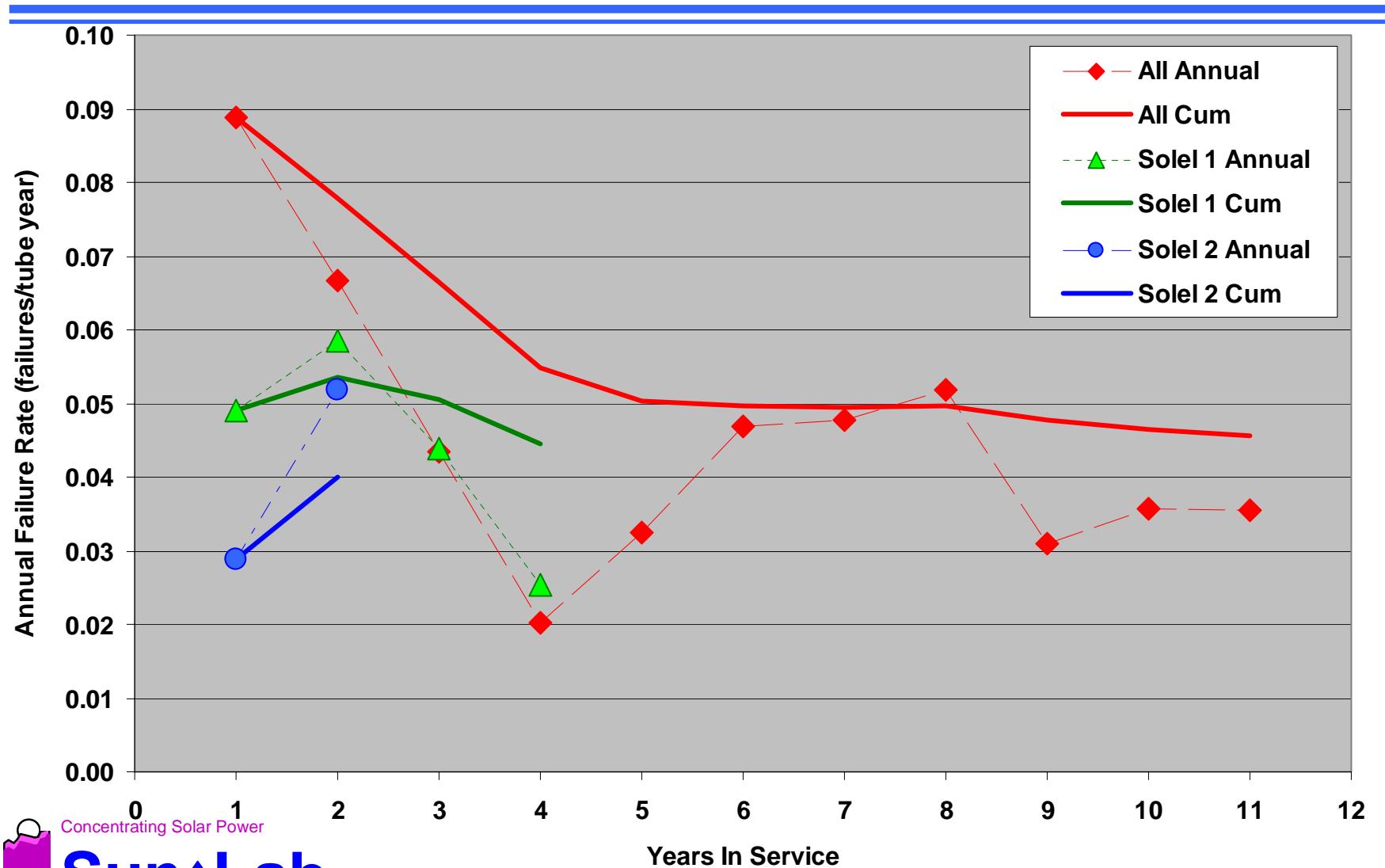
HCE (Receiver) Reliability - MWE Study

SEGS VII Failures by SCA Type



HCE (Receiver) Reliability - MWE Study

SEGS VI - HCE Glass Breakage Failure Rate



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HCE (Receiver) Reliability

**For improved HCE (receiver) reliability
technology must address:**

- Reducing failures of glass-to-metal seals
installation: flux and thermal protection ...
- Improving (significantly) air stability of solar selective
coating



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HCE (Receiver) Reliability Approach

Purchase and Test new Solel UVAC Receiver Solel Claims:

- Improved glass-to-metal seal
- Improved Air-stable cermet selective coating

Solar Absorptance 97% vs. 95.5%

Thermal Emittance @ 400C : 0.075 vs. 0.18

- Cleanable and improved anti-reflection (AR) coating on glass envelope

Solar Transmittance 97% vs. 96%

HCE (Receiver) Reliability Approach

In Field

SEGS O&M Company Testing and Support Task Ordering Agreement (TOA)

- Performance test (LS-2 test loop)
- Three year reliability monitoring (LS-2 & LS-3 collectors)
- Periodic optical properties assessment, thermal imaging
- Accelerate in-air stability evaluation (hottest locations,
remove glass, breach vacuum)

HCE (Receiver) Reliability Approach

In Laboratory

- Optical Properties Characterization
- Accelerated Thermal Aging various Temps
- Surface Analysis
- Glass-to-metal seal evaluation



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HCE (Receiver) Reliability Status

- **SEGS Test & Support Task Ordering Agreement**
 - KJCOC TOA In Place
 - FPL Energy (In Place ?)
- **RFP for Solel UVAC Receiver Task Order sent to KJCOC**
 - Purchase 350 tubes
 - Expect field install to begin early FY01
 - Expect approximately 40% cost share (half from Solel and half from KJCOC)

Retrofit Low Cost HCE (Receiver)

KJCOC Concept

Using existing cermet tubing

- Replace glass envelope and re-evacuate
glass-to-metal seal with adhesive - ongoing
SunLab support late FY00 - contract support
- Significant technical challenge
Expect initial limited success with this approach



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Retrofit Low Cost HCE (Receiver)

SunLab Alternative Approach

Using existing cermet tubing

- Apply protective (oxidation) coating over cermet
- Accelerate thermal aging (in air)
- Results promising

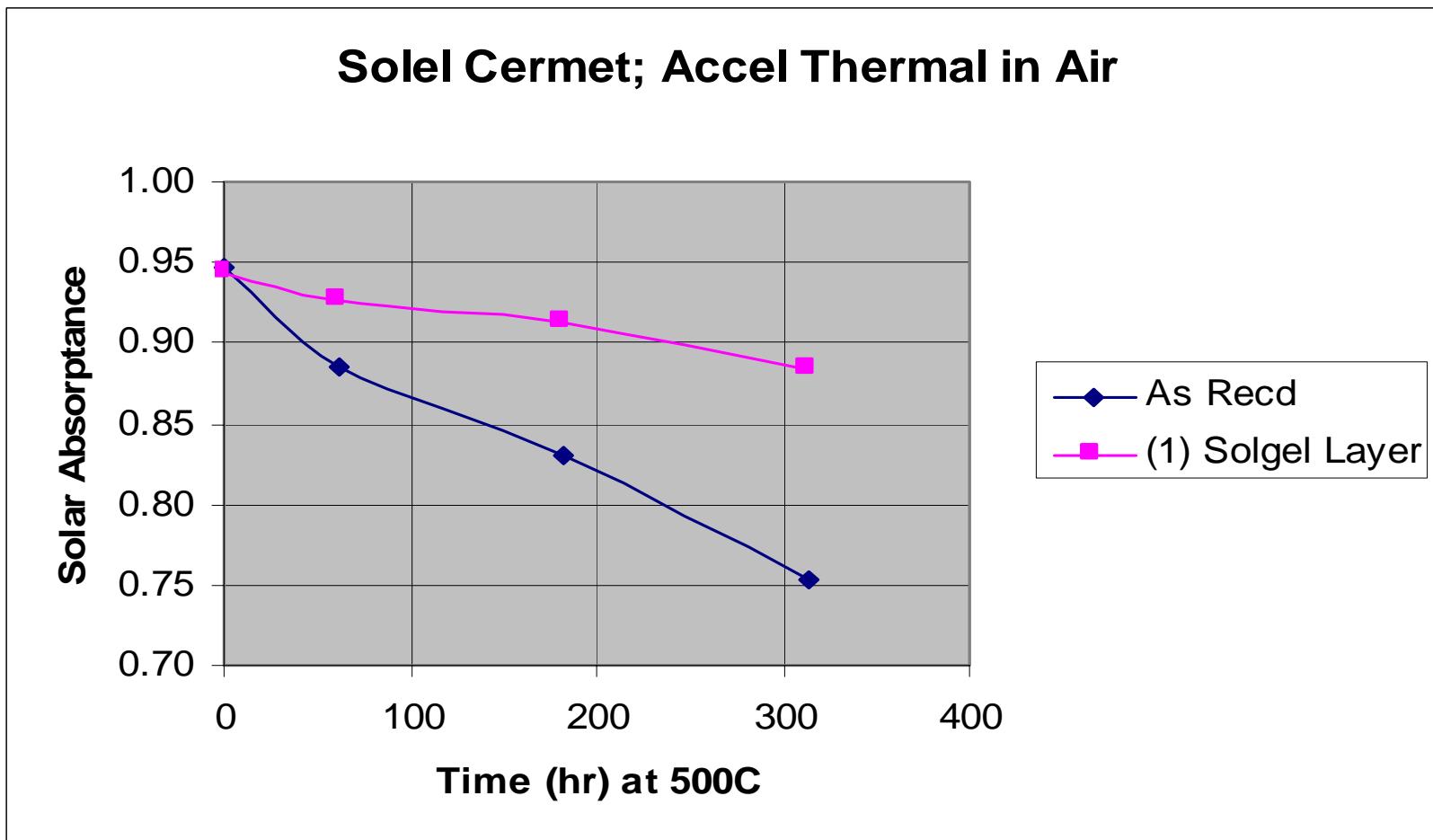


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Selective Absorber - Cermet

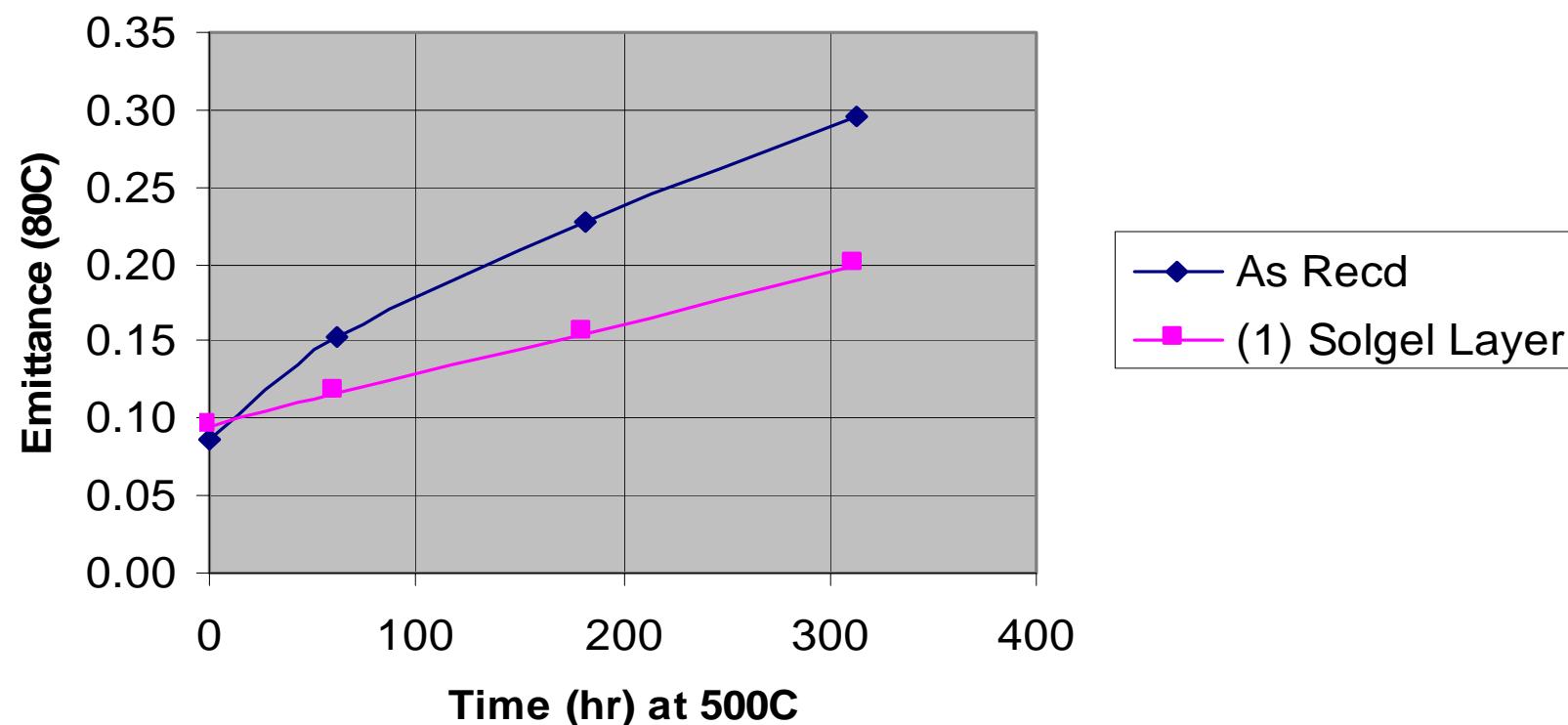


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Selective Absorber - Cermet



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Retrofit Low Cost HCE (Receiver)

SunLab Alternative Approach

Using existing cermet tubing

- Both KJCOC and Harper Lake very interested**

100s of “good” cermet tubes available

Harper: on-site assembly of glass envelope (plus ...)

- Prototype coating operation at Energy Laboratories, Inc. (ELI)**
- Full length tubing (4 meters) process - spring 2001**
- HCE cost <\$250 each (non-evacuated, not installed, ...)**



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Black Crystal Solar Selective Absorber

CRADA Amendment with ELI - Feb 2000

- **Black Crystal to higher temps**
stainless steel substrate
surface preparation critical
good in-air thermal stability to 375C ...
- **Process scale-up to full length tubing**
- **Prototype tubing ready for field install early FY01**

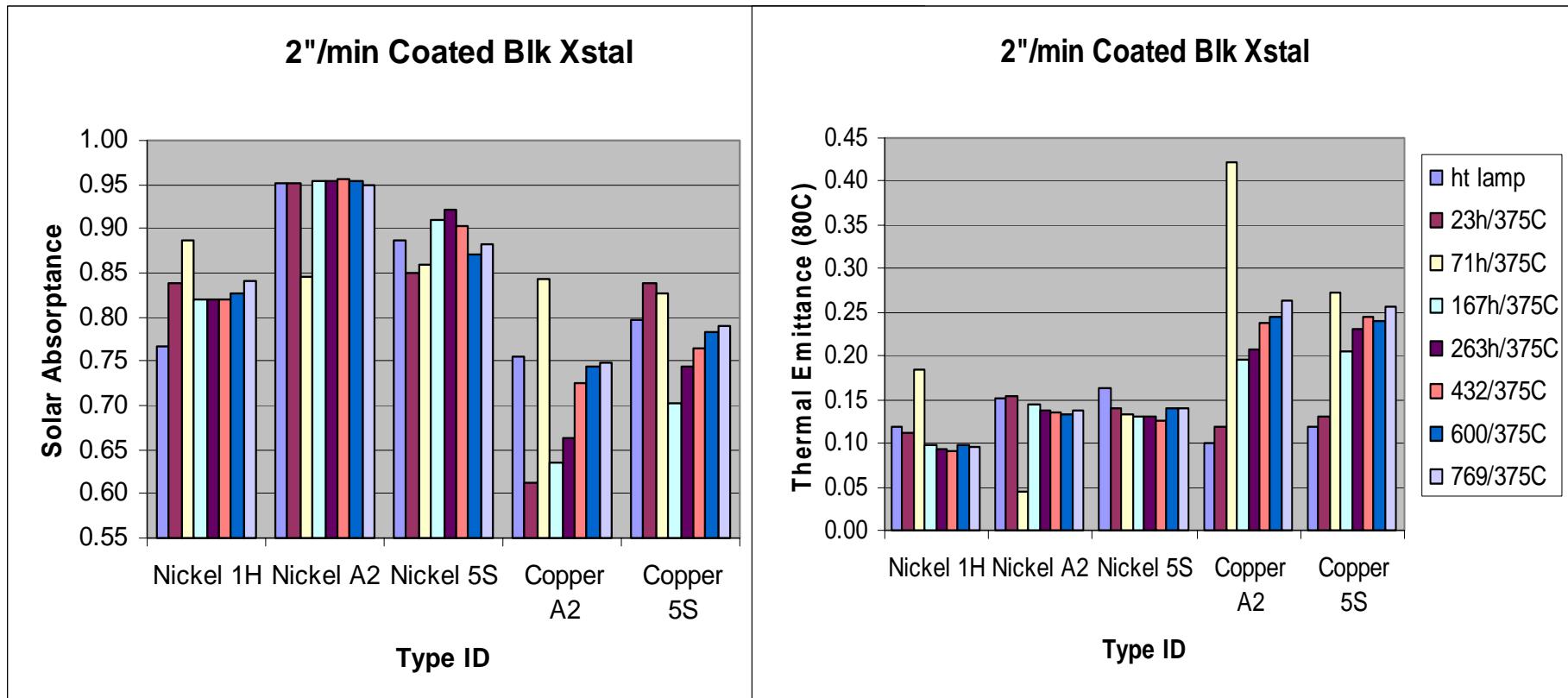


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Black Crystal Solar Selective Absorber



HCE Thermal Transfer Code

1-D code developed 1994 (Mancini, Sloan, Kearney)

Steady State Heat Loss and Gain - HCE

Converting to Visual Basic / Excel

- more user friendly
- adding features and options
 - additional fluids (molten salts)
 - glass envelope (coatings, heat mirror)
- plotting

Beta version - under evaluation



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Summary

Heat Collector Element (HCE) - Selective Absorbers

- **HCE Failure Data at SEGS VI & VII**
- **Purchase and Test new Solel UVAC Receiver**
install early FY01
- **Apply protective (oxidation) coating over cermet prototype** - autumn 2000
- **Black Crystal on tubing prototypes** - early FY01
- **Modernized HCE Heat Transfer Code**

release Aug 2000